Smart Greenhouse

Written By: Tyler

TOOLS:

- Computer running Windows XP, Vista, or Mac OS X (1)
- Electrical Tape (1)
- Hot Glue gun & hot glue (1)
- Laser cutting facilities (1)
- power drill and bit set (1)

PARTS:

- Parallax/Futaba servomotor (3)
- Arduino Uno (1)
- Breadboard kit (1)
- 1/8in OD flexible tubing (2ft)
- 1/8 in OD flexible tubing twist valve (1)
- 11"x8.5" rectangular planter box (1)
- wine cork (2)
- Parrallax LM 34 Temperature Sensor (1)
- Large Plastic Yogurt container (2)
- 2"x1" L-Bracket (2)
- 1.5" 3 pin PWM cable (1)
- 12"x24"x1/8in thick acrylic sheets (2)

SUMMARY

The Smart Greenhouse is based on the vision of a greenhouse that would maintain a perfect micro-climate for a particular crop being cultivated inside without relying on any human adjustment. In other words, ideally this greenhouse could be left for a year in any (reasonable) climate and the seeds that were meant to grow would flourish totally unattended. It would be perfectly tailored to the vegetation inside to maximize its efficiency. Such a greenhouse would require cognitive abilities to sense its surrounding environment and either use or block certain conditions while it preserves a micro-climate within the walls

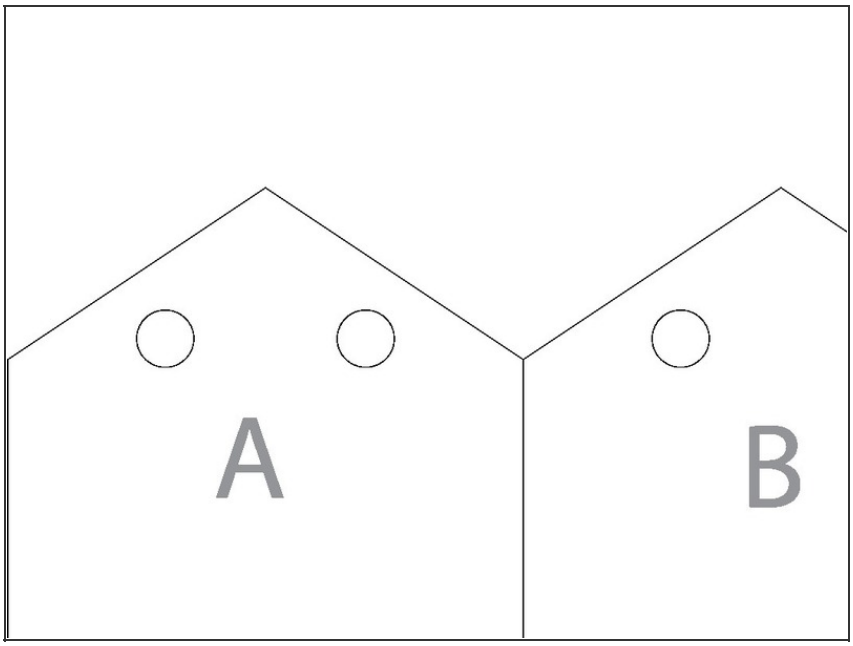
of the house.

Variables that are most important for crop success are those such as air temperature, soil moisture and humidity level. This particular model greenhouse addresses two of these factors: air temperature and soil moisture. The greenhouse utilizes an Arduino UNO microprocessor and various sensors to regulate these two variables within a desired set of thresholds. These thresholds will, of course, vary with the type of crops that one would want to grow in the greenhouse. Inside the structure is a Texas Instruments LM 34 sensor which measures air temperature. This sensor informs the Arduino which then controls opening and closing of roof servos to let hot air out and cool air in if the greenhouse is overheating. By use of the mechanical roof the greenhouse can autonomously keep the inside temperature to a desired level, assuming that this level is somewhat within the natural range of the surrounding environment. Additionally, the Smart Greenhouse has an irrigation system triggered by a timer function in the code that can be varied in frequency depending on a plant's optimal watering cycle. The timer activates the internal drip irrigation via a servo-controlled valve.

A possible addition to the Smart Greenhouse would be a soil-moisture sensor. This sensor could inform the drip irrigation system when the soil is too dry, creating a need-based watering pattern and potentially conserving water.

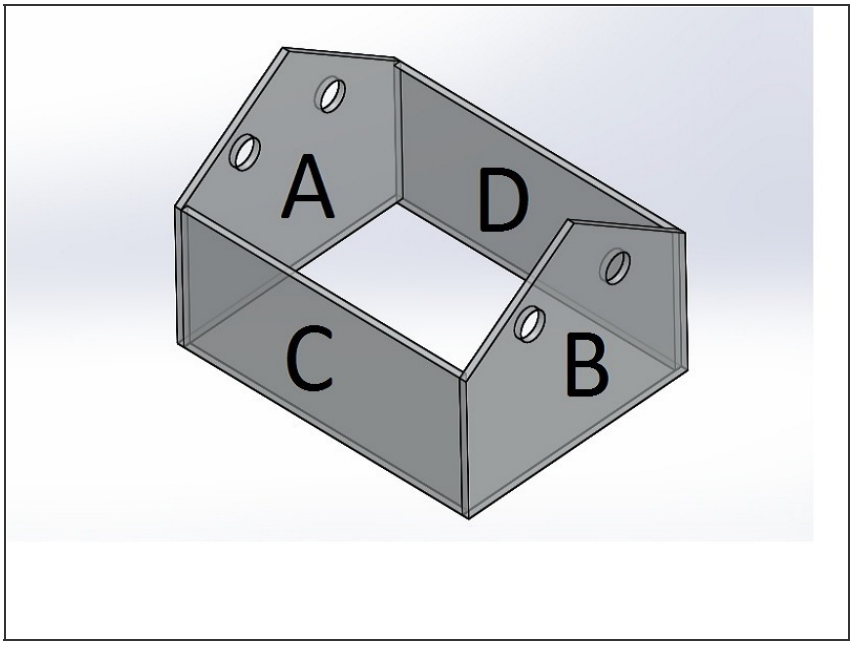
All these features make the Smart Greenhouse one of the most intelligent and cost-effective of its kind. There are still possibilities for other additions to this system to improve its versatility and efficiency.

Step 1 — Smart Greenhouse



- The first step is to build the model greenhouse.
- Go here for the Adobe Illustrator template files for the pieces.
- Using a laser cutter, cut out pieces from 1/8"-thick acrylic.
- Label the pieces with the letters shown in the Illustrator files.

Step 2

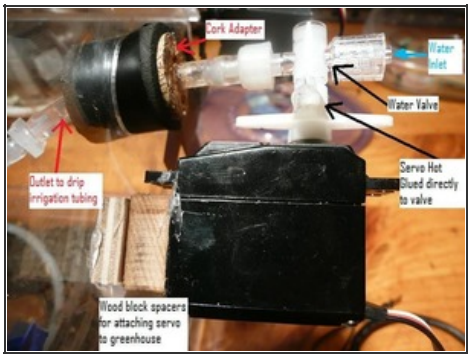


- Assemble greenhouse using labeled pieces and picture at right as a guide.
- Use Weld-On acrylic cement to attach pieces together.
- For best results use a plywood jig for cementing at right angles and apply pressure for up to four minutes while cement sets.

Step 3

- Attach a Parallax servo to each to each roof panel with hot glue.
- Using an L-bracket, attach the servo and roof panel to the front wall of the greenhouse with hot glue as shown.

Step 4

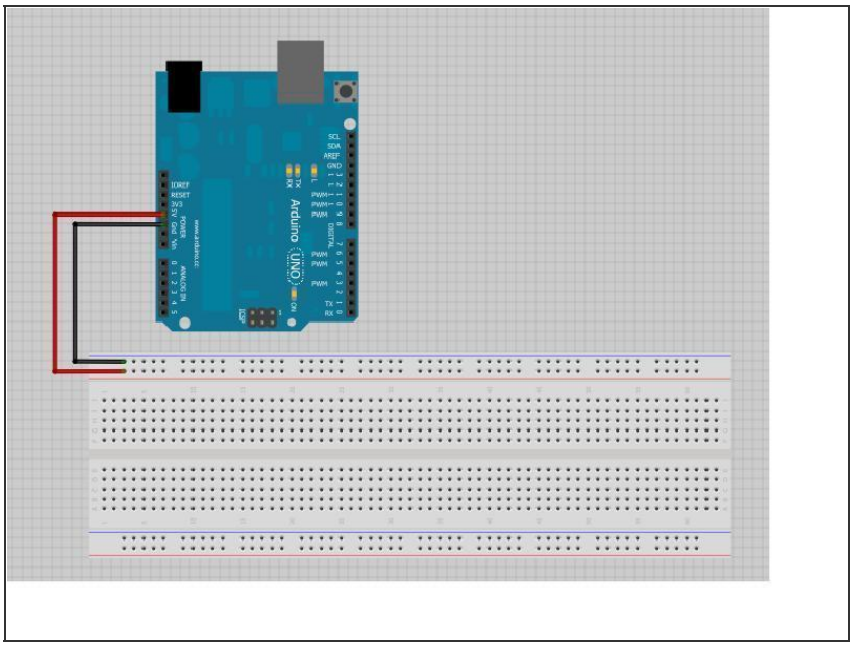


- Assemble irrigation system as shown.
- Hot glue servo to valve handle.
- Hot glue servo to greenhouse using wood spacers if necessary.
- Using an X-Acto knife, pierce the flexible tubing every inch along the section that lies on the soil in the greenhouse.
- This will create a drip irrigation system.

Step 5

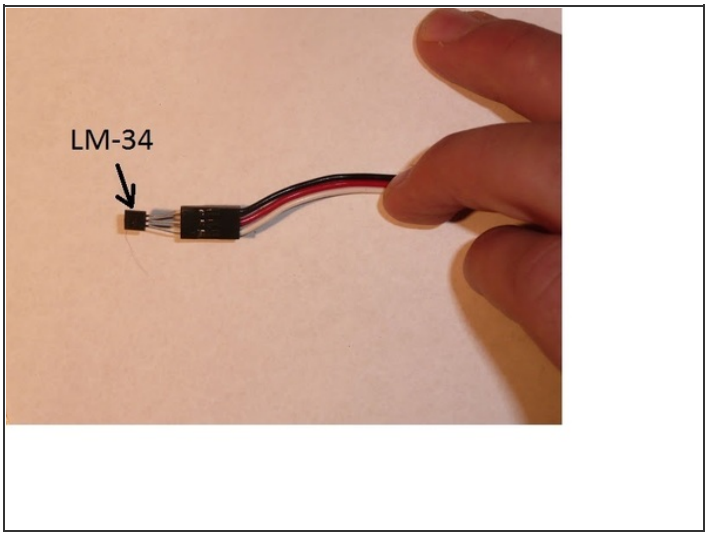
- Create water tank by drilling hole in bottom of yogurt container and making water-tight attachment to tubing that goes to input of servo valve.
- Use second yogurt container to elevate the water tank.

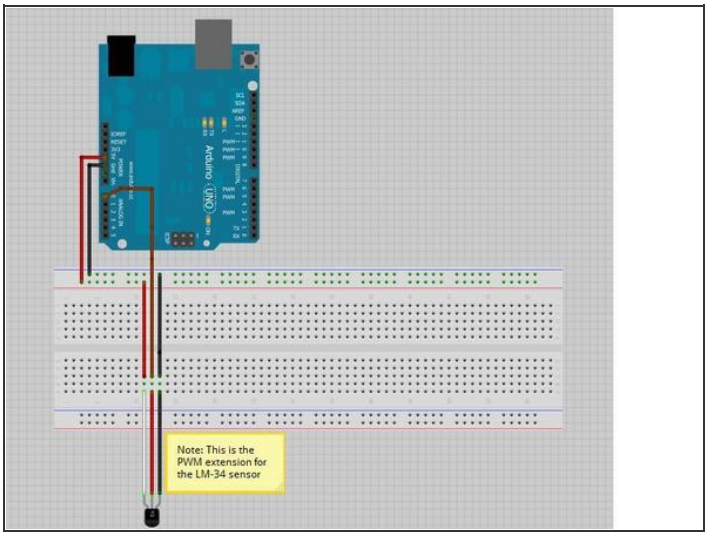
Step 6



- Now that all the hardware has been constructed it is time for electronics!
- Prepare the Arduino and breadboard as shown in the diagram.
- Connect red jumper cable from 5v on Arduino to red power rail on breadboard.
- Connect black jumper cable from GND on Arduino to black power rail on breadboard.

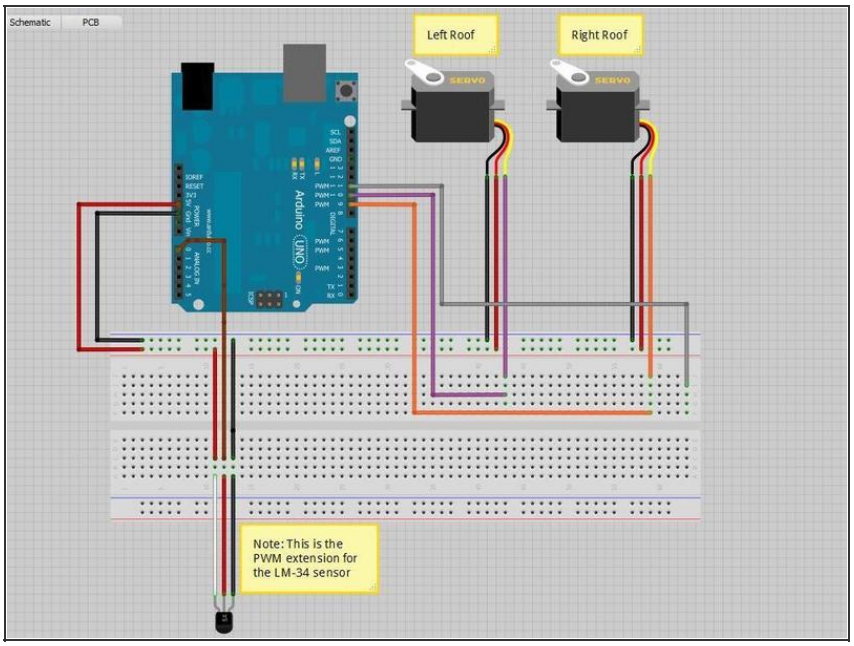
Step 7





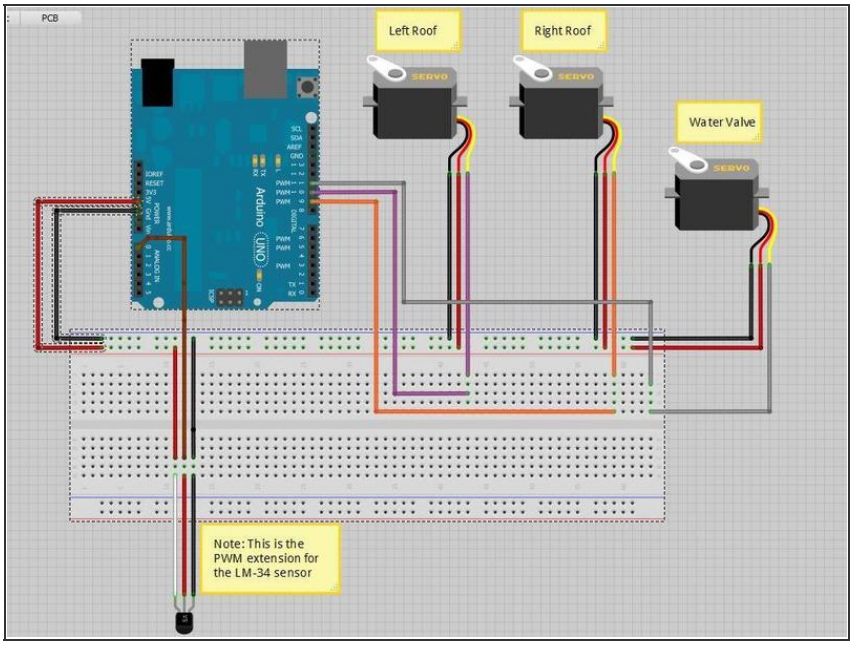
- Attach LM-34 Sensor to PWM extension cable.
- Note that the flat side of the LM-34 sensor is facing **up**.
- Now, Ground is the black wire, Analog Out is the red wire, and +5v is the white wire on the PWM extension cable.
- Wire sensor to breadboard and from breadboard to Arduino as shown in diagram.
- Be sure that the black wire from the PWM gets wired to GND, the white wire to 5v and the red wire to Analog 2 (A2).
- Thread the PWM cable with sensor through one of the access portals (round holes) on the front of the greenhouse and have the senor hang in the center of the greenhouse about 3" from the ground.

Step 8



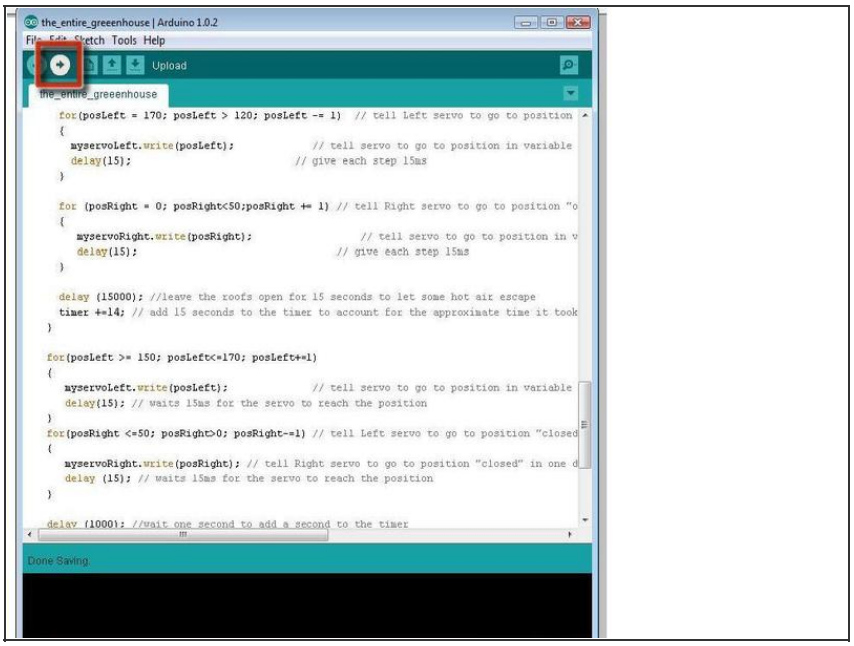
- Wire the two roof servos as shown in diagram.
- Be sure that the right roof servo goes to Digital 9 and the left roof servo goes to Digital 10 on the Arduino.

Step 9



- Wire the water valve servo as shown.
- Make sure that the white wire from the servo gets connected to Digital Output 9 (D11) on the Arduino.

Step 10



- Go here to retrieve the Arduino code for downloading to the Arduino Uno board.
- Open the .ino file in the Arduino coding platfrom (if not downloaded, get it here).
- Make sure "Arduino Uno" is selected under **Tools→Board**.
- Make sure correct serial port is selected in **Tools→Serial Port** for USB jack you will use to connect to Arduino.
- Download code to board using screenshots for guidance if necessary.
- Feel free to edit code for personal use. Specifically, you may want to play around with the `desiredTemp` variable and the watering cycle timer for the values that would be ideal for your greenhouse needs!

Step 11

- Your greehouse should be all set to self-regulate.
- From here, make any tweaks, additions, improvements, etc. that you see fit and post them to this article!
- Happy farming!

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